DOCUMENT RESUME

ED 249 742 EC 170 854

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TITLE The Role of Inference in Effective Communication.
PUB DATE Jun 84
NOTE 16p.; A Working Paper presented at the International Symposium on Cognition, Education, and Deafness (Washington, DC, June 5-8, 1984).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Students; *Communication Skills; *Hearing Impairments; *Logical Thinking
IDENTIFIERS *Inference

ABSTRACT

A study was conducted to determine whether speakers vary the explicitness of a message in accordance with a listener's likelihood of inferring the intended information. Thirty-six hearing and hearing-impaired college students were asked to read a series of 20 paragraphs. After each one, they were to re-tell the story in their own words to the examiner. The hearing-impaired students were instructed to use either speech or simultaneous communication, whichever was their more comfortable means of communication. After all the stories were finished, the Ss were given an instrument recall test. A coding of "1" indicated that the speaker explicitly mentioned the instrument along with the action. On the main dependent variable, the number of "1's," the performance of the hearing and hearing-impaired students were quite similar. For both groups the main effect of frequency was highly significant. The effect of importance approached, but did not reach, significance. There was a significantly greater tendency to explicitly mention the less likely or infrequent instrument than the frequent one. Thus both groups of speakers conformed to the Gricean Maxim of "quantity" by only being explicit when to do otherwise would have been misleading. The success of the speakers in drawing inferences was measured by the recall task. There were some differences here between the hearing and hearing-impaired speakers. The hearing speakers made very few errors in recall. However, the hearing-impaired speakers erred on 10-15% of the items, and almost all of these recall errors involved infrequent instruments. The study revealed that both hearing and hearing-impaired speakers structure their messages in accordance with the inferential needs of their listeners. It also suggested that both groups automatically infer the most likely instrument during input, but that the hearing-impaired speakers may be less sensitive to the resulting discrepancies. (Author/CL)

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ED249742

THE ROLE OF INFERENCE IN EFFECTIVE COMMUNICATION

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Abstract

Various factors influencing the drawing of inferences during discourse comprehension have been identified. However, it is not known whether these factors influence how explicitly speakers convey certain information. Do speakers structure their productions with their listener's inferential capabilities in mind? In particular, do they vary the explicitness of a message in accordance with a listener's likelihood of inferring the intended information?

This question was examined in terms of instrument inferences. It was hypothesized that if a highly likely instrument is used in an activity, speakers will not mention the instrument. However, if a less probable instrument is used, they will specify the object in order to counter the drawing of an incorrect instrument inference. Furthermore, it was hypothesized that explicitness would be influenced by the relative importance of the instrument later on in the discourse. These predictions were examined using hearing and hearing-impaired speakers.

Thirty-six college students were asked to read a series of 20 paragraphs. After each one, they were to re-tell the story in their own words to the examiner. The hearing-impaired students were instructed to use either speech or simultaneous communication, whichever was their most comfortable means of communication. After all the stories were finished, the subjects were given an instrument recall test.

A coding of "1" indicated that the speaker explicitly mentioned the instrument along with the action. On the main dependent variable, the number of "1's," the performances of the hearing and hearing-impaired students were quite similar. For both groups the main effect of frequency was highly significant. The effect of importance approached, but did not reach, significance.

There was a significantly greater tendency to explicitly mention the less likely or infrequent instrument than the frequent one. Thus both groups of speakers conformed to the Gricean Maxim of "quantity" by only being explicit when to do otherwise would have been misleading.

The success of the speakers in drawing inferences was measured by the recall task. There were some differences here between the hearing and hearing-impaired speakers. The hearing speakers made very few errors in recall. However, the hearing-impaired speakers erred on 10-15% of the items and almost all of these recall errors involved infrequent instruments.

The study thus revealed that both hearing and hearing-impaired speakers structure their messages in accordance with the inferential needs of their listeners. It also suggested that both groups automatically infer the most likely instrument during input, but that the hearing-impaired speakers may be less sensitive to the resulting discrepancies.

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Introduction

Numerous studies of discourse comprehension have substantiated the importance of inferential processing. Listeners draw a variety of inferences when they comprehend utterances, ranging from the inferring of the speaker's communicative intent (Clark, 1978) to the inferring of the referent for an anaphor (McKoon & Ratcliff, 1980). Though the process of drawing inferences is not fully understood, it appears that some inferences are harder to draw than others and that inferences difficult to make impede comprehension (Kintsch & Vipond, 1979). While some of the conditions requiring inferences have been identified, such as when an inference is necessary for text cohesion (Singer, 1980), the question of how inferences are constrained by cognitive and pragmatic conditions remains unanswered.

During a conversation constraining a listener's inferences to those intended by the speaker might be desirable. How could this be accomplished? One way is for the speaker to get the listener to recognize which inferences he/she intends the listener to draw. In his theory of speech acts, Searle (1971) claims that a speaker succeeds in performing a certain communicative act if the listener recognizes the speaker's intent to perform this act. This recognition is achieved by the speaker abiding by certain rules or conventions for expressing that intention. For example, the utterance "it's cold in here" serves as a request to close the window if the listener recognizes the speaker's intent to make such a request. Clark (1978), expounding upon Searle's speech act theory, has developed a problem-solving model of how a listener infers the intended interpretation of an utterance. He claims that tacit agreements between a speaker and listener about how language is used constrains the drawing of inferences. Speakers and listeners have agreements about particular conditions that must be met, for example conditions regarding form, content, or appropriateness. For an inference to be

drawn the conditions specified in the agreement must be met. He discusses specific agreements for inferences related to indirect requests, definite references, and shorthand expressions.

In addition to agreements about language use which relate to linguistic and socio-cultural conventions, other rules might be motivated by cognitive processing considerations. One such agreement might be that speakers will produce messages that are closely adapted to the way listeners comprehend information. Information may be presented so that excessive demands are not placed on the listener. For example, speakers should not require listeners to draw difficult inferences.

Rules tied to the drawing of inferences should influence how explicitly speakers convey certain information. What might such an agreement look like? One agreement might specify that speakers should be informative, and not present information that the listener already knows or that the listener can easily infer. In addition, they should not explicitly state information they consider irrelevant or unimportant (Grice, 1975). The present study examined whether such a tacit agreement about explicitness is operating during communication.

In addition to examining this behavior in general, this study compared the performance of hearing and hearing-impaired speakers on the task. While the communication difficulties of the latter group have been studied extensively with regard to channel limitations and linguistic deficiencies, the contribution of other factors has received minimal attention. In particular, little is known about the cognitive bases for communication difficulties. If some type of tacit agreement exists that speakers will adapt the explicitness of their messages to the inferential needs of their listener, violations of this agreement may impair communication. Listeners may have difficulty comprehending a message when their expectations about the presentation of information are not met. Do deaf speakers

adapt their messages to the cognitive processing of their listener so as to regulate their listener's inferential processing appropriately?

Deaf individuals often limit their interpretations of English sentences to the directly stated information. They consequently experience difficulty on reading comprehension tasks when they need to draw inferences from the explicit text. If deaf individuals are not routinely engaged in inferential processing, they may not be sensitive to a listener's potential drawing of inferences. Consequently, they might not vary the explicitness of their message to accord with their listener's inferential needs.

In this study, the tacit agreement about explicitness was examined in terms of instrumental inferences. How listeners comprehend instrumental inferences has been studied extensively. If listeners hear about an action, they can infer what tool or object was used to accomplish it. For example, a speaker does not need to say "The girl ate the pudding with a spoon." The listener, using world knowledge, can infer that she used a spoon to do the eating.

The relative likelihood of different objects being used to accomplish particular actions has been assessed using sentence completion tasks (Corbett & Dosher, 1978). It has been found that an action can have a strongly associated instrument and that if the instrument is left implicit, the listener will infer that the most likely object was used (McKoon & Ratcliff, 1981). For example, if listeners hear that someone pounded a nail they assume it was with a hammer.

If probable instruments are indeed easily inferable, it would be interesting to note whether speakers treat these instruments accordingly when describing activities. According to the suggested agreement regarding explicitness, a speaker should not mention an instrument if it is easily inferable or if it is unimportant. This specific agreement was examined in the current study. Speakers told

stories involving actions that could be accomplished with more than one instrument. In one version the instrument used was the one typically associated with the action; in the other version the instrument was plausible, but less typical. In addition the significance of the instrument was varied so that which instrument was used was important in one version, but not in the other.

The first hypothesis being tested was that atypical instruments would be mentioned more often than typical. A speaker would not explicitly mention typical instruments with their associated activities since they could be easily inferred and probably would be inferred by a listener. Considering this bias toward the most likely instrument, a speaker would explicitly mention the instrument used if it was other than the most probable. For example, if a knife was used in a stabbing, a speaker would state: "The robber stabbed the man." However, if an ice pick was used the speaker would say: "The robber stabbed the man with an ice pick." The second hypothesis was that whether or not an instrument was mentioned explicitly would vary with the importance of the instrument in the subsequent discourse. It would be more crucial for the listener to know which instrument was used when the instrument was important to the progress of the story than when it was irrelevant. The speaker would hence explicitly mention important instruments more frequently than unimportant ones.

Method

Subjects

Forty students, twenty hearing and twenty hearing-impaired, participated in this study. The hearing students were enrolled in an introductory psychology course at the University of Rochester and volunteered for the study in partial fulfillment of a course requirement. The only constraint on their participation was that they be native speakers of English. The hearing-impaired students who

attended the National Technical Institute for the Deaf at the Rochester Institute of Technology were each paid four dollars for their participation. The hearing-impaired students volunteering for the study were required to have at least an eighth grade reading level, as measured by the California Reading Test. The average reading level for the group was the ninth grade. The pure tone averages of the students ranged from 58 dB to 113 dB, with a group mean PTA of 87 dB. All of the students had semi-intelligible to intelligible speech.

Materials

Twenty actions that normally involve instruments were selected. For each action, two instruments were identified: the one most frequently associated with the action and another plausible but less likely candidate. For example, for the action "pounding a nail," "hammer" and "mallet" were selected respectively. The instrument frequencies were verified by a sentence completion task. Twenty-three undergraduates were asked to write down the first instrument that came to mind when they read a sentence. The most frequently mentioned instrument was considered the most probable. The most probable instruments were chosen 74.8% of the time and the less probable ones 12.2% of the time.

Twenty short stories depicting characters performing the different actions were composed. Each story had four versions. These versions were derived by crossing the two experimental factors, whether the instrument was frequently or infrequently associated with the action, and whether the instrument was important in the story, i.e., whether it was mentioned later on or not. An example of a story with its four versions is shown in Table 1. The stories were composed so that in either the first or second sentence the target action was mentioned without explicit reference to the instrument used. The instrument was explicitly mentioned in the following sentence. The importance of the instrument was revealed in the final sentence of the paragraph. Four lists of stories were

Table 1

An Example of the Paragraphs Used in the Experiment

A. Frequent-important instrument: knife

The robber hid behind the door and when the man entered the kitchen he stabbed him in the back. He wiped the blood off the knife and rummaged through the drawers. Later police investigators found his fingerprints all over the knife and had no trouble catching him.

B. Frequent-unimportant instrument: knife

The robber hid behind the door and when the man entered the kitchen he stabbed him in the back. He wiped the blood off the knife and rummaged through the drawers. Later police investigators found his fingerprints all over the drawers and had no trouble catching him.

C. Infrequent-important instrument: ice pick

The robber hid behind the door and when the man entered the kitchen he stabbed him in the back. He wiped the blood off the ice pick and rummaged through the drawers. Later police investigators found his fingerprints all over the ice pick and had no trouble catching him.

D. Infrequent-unimportant instrument: ice pick

The robber hid behind the door and when the man entered the kitchen he stabbed him in the back. He wiped the blood off the ice pick and rummaged through the drawers. Later police investigators found his fingerprints all over the drawers and had no trouble catching him.

assembled so that each list contained all twenty stories, and there were five stories in each condition. Across the four lists each story's version was represented once. Thus, for example, list one had story 11 in version 1, while list two had the same story in version 2, and so on. Each subject received a single list of 20 randomized stories. An equal number of subjects, five hearing and five hearing-impaired, received each list.

Procedure

Subjects were tested individually in a single 20-30 minute session. Before beginning the test items, they received one practice story to assure their under-

standing of the task. The subjects were then presented a stack of twenty 3x5 index cards, with one story typed on each card. They were instructed to read a story carefully and to then retell it to the examiner as clearly and completely as possible. Students were told that they could read the story as many times as necessary to understand it but that they were not to memorize the sentences. They were to convey the ideas in their own words so that their listener fully understood what happened. Students were encouraged to keep the card in their hand when telling the story and to refer to it if they needed to verify information. The stories of the hearing subjects were recorded on audiotape. The hearing-impaired subjects were videotaped as several of them used simultaneous communication. They were encouraged to use either signs plus speech or speech alone, whichever was their more comfortable means of communicating. At the end of the twenty stories, the students performed an instrument recall task. The examiner cued them with the character and the action, and they were to respond with the instrument.

Results

Each story was transcribed and then analyzed using a four category coding scheme to characterize the explicitness of an instrument's mention. Each story received one rating. A story received a rating of "1" if the target instrument was named explicitly when the action was mentioned. For example, the following all received ratings of "1": "Elizabeth ate rice with chopsticks," "Elizabeth used chopsticks to eat rice," and "Elizabeth ate rice. She used chopsticks." A passage was coded as a "2" if the instrument was mentioned in conjunction with some activity occurring subsequent to the focal action. For example, the following was rated a "2": "The Girl Scout lit the fire. Then she put away her lighter." In a "1" passage the listener is told explicitly which instrument was used; in a "2" passage the listener must infer that the instrument mentioned

subsequently was the one involved in the target action. If the speaker did not name the instrument until the end of the passage it was coded as a"3"; a "4" indicated a failure to mention the instrument at all. All of the stories were rated by one coder. One-half of the stories were coded by a second scorer to test for reliability. The inter-judge agreement was 92%.

Two analyses were performed. The first was on the number of "1's" and the second was on the percentage of "non-1's" that were "2's," i.e., the number of "2's" divided by the total number of "2's," "3's" and "4's." For each of these measures an analysis of variance with hearing status as a between-subject factor and frequency and importance as within-subject factors was performed on the means for each condition for each subject (F_1 statistic) and the means for each condition for each story (F_2 statistic).

The first analysis, on the number of "1's," yielded significant main effects for frequency, $F_1(1,32)=21.36$, $p < .01$; $F_2(1,16)=7.77$, $p < .01$, and importance, $F_1(1,32)=11.52$, $p < .01$; $F_2(1,16)=10.27$, $p < .01$. The effect of hearing status was not significant and there were no significant interactions. The total number of "1's" for each group for each condition is shown in Table 2.

Table 2

Total Number of "1's"
(Explicit mention of instrument with the action)
As a Function of Conditions

	Hearing		Hearing-Impaired	
	Frequent	Infrequent	Frequent	Infrequent
Important	26	47	32	42
Not Important	22	34	18	34

Note: 100 is the highest possible total for each cell

The probability of an instrument being associated with an action was a significant factor in its specification. Speakers explicitly stated the instrument in an action 39% of the time when the instrument was less frequently associated with that action versus 24% of the time when the instrument was that most frequently associated with the action. The mentioning of an instrument was also influenced by the instrument's importance in the story. Important instruments were specified more often (37%) than unimportant instruments (27%).

The lack of a main effect of hearing-status shows that the two groups were equally likely to explicitly state instruments. The lack of any interaction between hearing status and the other two variables indicates that hearing-impaired subjects are influenced by instrument frequency and importance in the same way that hearing subjects are. Both hearing and hearing-impaired speakers explicitly mentioned instruments when they were atypical or important.

The second analysis, the percentage of "non-1's" that were "2's," revealed that the effect of frequency and importance did not influence whether the instrument was mentioned subsequent to the focal action in the story. This was true for both hearing and hearing-impaired speakers. Thus, the experimental manipulation only affected the immediate mention of the instrument, not the subsequent mention.

Instrument recall measures were gathered on 80% of the hearing-impaired students, and on 30% of the hearing students. The percentage correct recall scores suggest some group differences in performance. The hearing subjects nearly always (99.3%) correctly recalled the instrument. However, the hearing-impaired subjects failed to recall them 15% of the time. Interestingly, 85% of these errors were on infrequent instruments. It is possible they forgot what happened and thus inferred the most likely instrument at recall. An alternate explanation is that during reading they immediately inferred the most likely instrument and

did not revise that inference when it was contraindicated by subsequent information. This latter explanation is supported by two observations: (1) only two (.03%) of the instruments missed at recall were mentioned explicitly as "1's" during the communication task, and (2) 74% of the errors occurred on the version when the instrument was unimportant later on in the passage. In this version, information contradicting a wrong inference is less salient than in the important version.

Discussion

This experiment supported the existence of a tacit agreement concerning explicitness and illuminated two conditions operating on explicitness: informativeness and importance. To be state explicitly, an instrument's mention must meet one or both of these conditions.

The first hypothesis of the study, that speakers would explicitly mention atypical instruments more often than typical ones, was supported. It appears that conventional knowledge about the world, such as an instrument's use, is treated as shared or given information in a conversation and hence does not need to be specified directly. To do so would violate the informativeness condition on explicitness. Speakers expect their listeners to infer that the most typical instrument was used unless they are told otherwise. They can reserve explicit mention of the instrument for instances when they must signal a departure from this normal expectation.

We speculated that the explicit mention of atypical instruments would be motivated by a desire to prevent the listener from inferring the wrong instrument, i.e., the most probable one. The finding that frequency affected the immediate and not the subsequent mentioning of an instrument supports this reasoning and suggests that speakers expect their listeners not only to infer the most likely

instrument but to do so when encoding the action. Any countering of a wrong inference therefore needs to be accomplished immediately.

The second hypothesis, that speakers will explicitly mention important instruments more often than unimportant ones, was also supported. However, we expected to find an interaction between instrument frequency and importance. We had predicted that specifying an atypical instrument in order to prevent an incorrect inference would be particularly crucial if the instrument was important later on in the story. The fact that both probable and less probable instruments were mentioned explicitly when they were important suggests that explicitness serves more than a clarifying function. It also serves to establish focus. The explicit mention of an expected instrument is not just redundant, it instructs the listener to keep the referent activated in anticipation of forthcoming information.

So the results of this study suggest that the explicit mentioning of an instrument serves a special purpose. It either informs the listener that the instrument is atypical and not the one expected through default knowledge or it signals to the listener that the instrument is to have some significance later on in the discourse and should be noted. In either case it appears that speakers attempt to guide their listener's comprehension. They attempt to make their messages more comprehensible by (1) making sure that their listener is not misled and (2) setting up expectations about what is to come.

The fact that the performance of the hearing and hearing-impaired students was comparable merits attention. Being hearing-impaired does not necessarily imply deficiencies in the type of communication explored by this task. The findings indicated that hearing-impaired students as well as hearing students were cooperative communicators. In particular, they abided by the hypothesized explicitness agreement. In modifying what they told their listener they considered what

their listener already knew via world knowledge. The hearing-impaired subjects were thus demonstrating competencies in two areas frequently considered to be deficient in deaf communicators: (1) they adjusted to their listener's needs and (2) they accessed world knowledge to constrain their productions.

The hearing and hearing-impaired speakers followed a similar rule for the explicit mention of instruments. However, this finding must be interpreted cautiously. Since only one tacit agreement concerning the explicit meantion of one type of inference was investigated, broader claims about hearing-impaired speakers adapting to the cognitive needs and expectations of their listeners cannot be made.

In this experiment, instrumental inferences were specifically selected because they are easy to draw. A speaker's responsiveness to this ease could thus be evaluated. However, the ease with which instrumental inferences are drawn may have been a factor in the performance of the hearing-impaired subjects. Instrumental inferences are based upon conventional knowledge that is well within the experience of the deaf participants; they are drawn in order to embellish content; and the objects which are inferred are concrete referents that are highly salient.

It was hypothesized that implicit knowledge about inferential processing constrains production. A speaker's own ability and experience at drawing inferences may provide this knowledge so that adapting to a listener's inferential demands may vary with the difficulty of the inference being drawn. Perhaps deaf speakers would be less competent with more complex inferences such as macrotextual inferences that combine propositions or contextual inferences that establish an organizational framework for interpreting sentences.

Another characteristic of the task that may have influenced the performance of the hearing-impaired speakers was that the linguistic demands of the explicitness agreement were minimal. When the conditions called for explicitness, the

speaker only needed to mention the instrument. Adapting to the inferential needs of the listener was within the speaker's linguistic competence. Deaf speakers may have difficulties satisfying other agreements that require more sophisticated linguistic strategies, such as the structuring of propositions in terms of importance.

The comparable performance of the hearing and hearing-impaired speakers in this study and the suggestion that differences might be found if either the cognitive (i.e., inferential) or linguistic demands of the task were increased provide some direction for future research. It seems that exploring the rules governing the structure of discourse and identifying violations of these rules as sources of communication difficulties merits further investigation.

Another direction for future research would be to look at the performance of hearing-impaired students with reading levels below eighth grade. Would they perform differently on this task? If so, why? The relationship between reading skill and performance on this task needs investigating. It is possible that reading at the eighth grade level instilled some type of minimum proficiency in the students. If so, the nature of this proficiency needs exploring. Students with higher reading levels are generally considered more competent users of the English language. They may also be more likely to obtain knowledge about the world and discourse structure from what they read. In addition, performing at that level probably indicates some competence at drawing inferences. Skill in any of these areas may have influenced performance on the task.

It would also be interesting to note whether the same rules for explicitness apply to signed communication or whether they are English language specific. A finding that the rules cross languages and modalities of communication would provide strong evidence that the explicitness agreement is motivated by cognitive processing considerations.

Summary

This study thus revealed that both hearing and hearing-impaired speakers structure their messages in accordance with the inferential needs of their listeners. They expect their listeners to infer that the most likely instrument was used for an action. In addition they expect this inference to be drawn immediately after the action is mentioned. They therefore counter this inference when it is incorrect by explicitly mentioning the correct instrument. Both groups of speakers also use the explicit mentioning of an instrument to signal its importance in the text. It thus appears that message production involves implicit knowledge about the way information is comprehended and about the discourse features that facilitate comprehension.

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